CLAIMS

1. An optical component comprising:

a substrate;

an opaque layer on a first side of the substrate, the opaque layer defining an aperture to transmit light;

a first meta-surface, disposed in the aperture on the first side of the substrate, to reshape or modulate light incident on the first side of the substrate at different angles; and

a second meta-surface, on a second side of the substrate opposite the first side, to generate an optical pattern that varies as a function of an angle of incidence, a phase, an amplitude, a polarization, and/or a spectral property of the light reshaped, modulated, and/or transmitted by the aperture and the first meta-surface,

wherein the optical pattern is an array of dots or stripes.

2. The optical component of claim 1, wherein the first meta-surface is configured to modulate the light as a function of a phase, an amplitude, an angle of incidence, a polarization, and/or a spectral property of the light.

3. The optical component of claim 1, where the optical component is immersed in another material.

4. A sensor comprising:

an optical component comprising:

a substrate;

an opaque layer on a first side of the substrate, the opaque layer defining an aperture to transmit light;

a first meta-surface, disposed in the aperture on the first side of the substrate, to reshape or modulate light incident on the first side of the substrate at different angles; and

a second meta-surface, on a second side of the substrate opposite the first side, to generate an optical pattern that varies as a function of an angle of incidence, a phase, an amplitude, a polarization, and/or a spectral property of the light reshaped, modulated, and/or transmitted by the aperture and the first meta-surface,

wherein the substrate is a first substrate;

a second substrate;

a light source array, supported by a first portion of the second substrate and facing the optical component, to emit light through the optical component toward an object over a field of view;

a wide field-of-view meta-lens, in optical communication with the object, to collect the light scattered and/or reflected by the object over the field of view; and

a detector array, supported by a second portion of the second substrate and in optical communication with the wide field-of-view meta-lens, to detect the light collected by the wide field-of-view meta-lens.

5. The sensor of claim 4, wherein the optical component is configured to project the optical pattern into free-space over an angular range of at least 120°.

6. The optical component of claim 1, wherein the optical pattern is a two-dimensional optical pattern.

7. The optical component of claim 1, wherein the optical pattern is a three-dimensional optical pattern.

8. An optical component comprising:

a substrate;

an opaque layer on a first side of the substrate, the opaque layer defining an aperture to transmit light;

a first meta-surface, disposed in the aperture on the first side of the substrate, to reshape or modulate light incident on the first side of the substrate at different angles; and

a second meta-surface, on a second side of the substrate opposite the first side to generate an optical pattern that varies as a function of an angle of incidence, a phase, an amplitude, a polarization, and/or a spectral property of the light reshaped, modulated and/or transmitted by the aperture and the first meta-surface,

wherein the second meta-surface is configured to generate different sparse arrays of dots as a function of incidence angle.

9. The optical component of claim 1, wherein the first meta-surface is configured to collimate the light.

10. A method comprising:

transmitting light through an aperture defined by an opaque layer on a first side of a substrate;

reshaping or modulating the light at different angles with a first meta-surface disposed in the aperture on the first side of the substrate; and

generating, with a second meta-surface on a second side of the substrate opposite the first side, an array of dots or stripes that varies as a function of an angle of incidence, a phase, an amplitude, a polarization, and/or a spectral property of the light reshaped, modulated, and/or transmitted by the aperture and the first meta-surface.

11. The method of claim 10, wherein reshaping or modulating the light with the first meta-surface comprises modulating the light as a function of a phase, an amplitude, an angle of incidence, a polarization, and/or a spectral property of the light.

12. The method of claim 10, where the substrate is immersed in another material.

13. The method of claim 10, wherein the array of dots or stripes is a two-dimensional array of dots or stripes.

14. The method of claim 10, wherein the array of dots or stripes is a three-dimensional array of dots or stripes.

15. The method of claim 10, wherein the reshaping or modulating comprises collimating the light.

16. A method comprising:

transmitting light through an aperture defined by an opaque layer on a first side of a substrate;

reshaping or modulating the light at different angles with a first meta-surface disposed in the aperture on the first side of the substrate; and

generating, with a second meta-surface on a second side of the substrate opposite the first side, different sparse arrays of dots as a function of incidence angle of the light reshaped, modulated, and/or transmitted by the aperture and the first meta-surface.

17. A method comprising:

emitting light from a light source array supported by a first portion of a first substrate;

transmitting the light through an aperture defined by an opaque layer on a first side of a second substrate facing the first substrate;

reshaping or modulating the light at different angles with a first meta-surface disposed in the aperture on the first side of the second substrate;

generating, with a second meta-surface on a second side of the second substrate opposite the first side, an optical pattern that varies as a function of an angle of incidence, a phase, an amplitude, a polarization, and/or a spectral property of the light reshaped, modulated, and/or transmitted by the aperture and the first meta-surface;

collecting the light scattered and/or reflected by the object over the field of view with a wide field-of-view meta-lens; and

detecting the light collected by the wide field-of-view meta-lens with a detector array supported by a second portion of the first substrate.

18. The method of claim 17, wherein generating the optical pattern comprises projecting the optical pattern into free-space over an angular range of at least 120°.